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GB 2187836 A EP 0636332 A1 WO 93/02533 A1

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(54) Improving lateral conduction in electric heating elements

(57) There is disclosed a heater 2 comprising a support surface 4, an electrically insulating layer 6 on the surface 4, and a resistive heating track 8, applied to the insulating layer 6. A thermal conduction means 20 is arranged in thermal contact with the heater track 8 to improve lateral conduction of heat produced by the track 8.

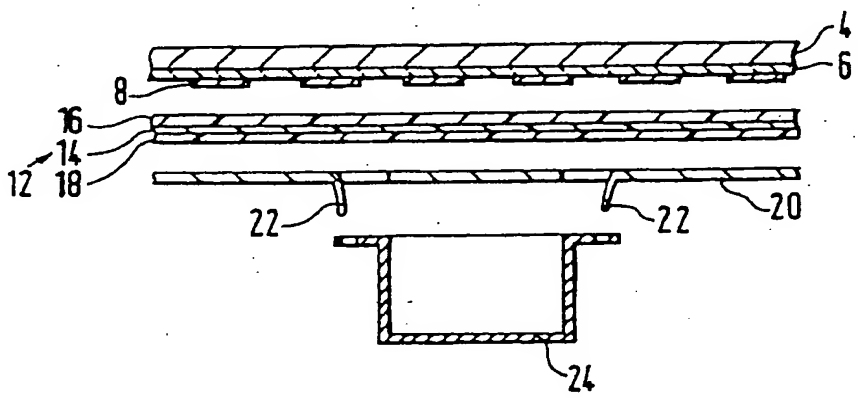

FIG.2

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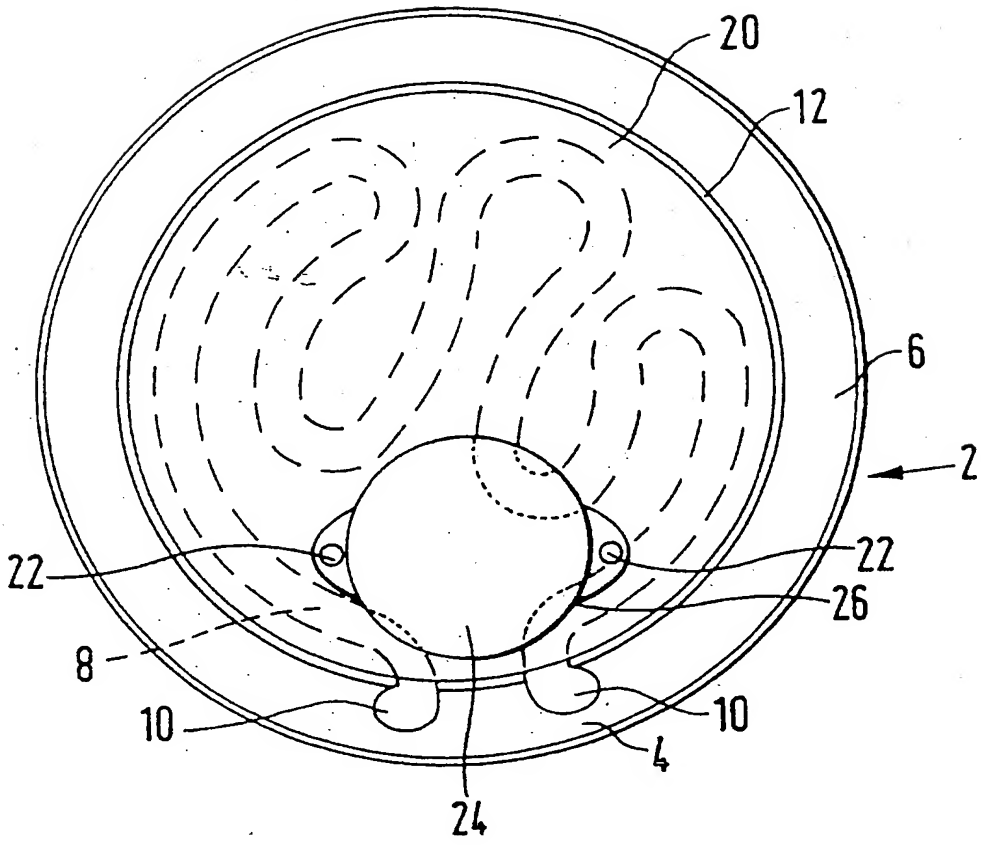

FIG.1

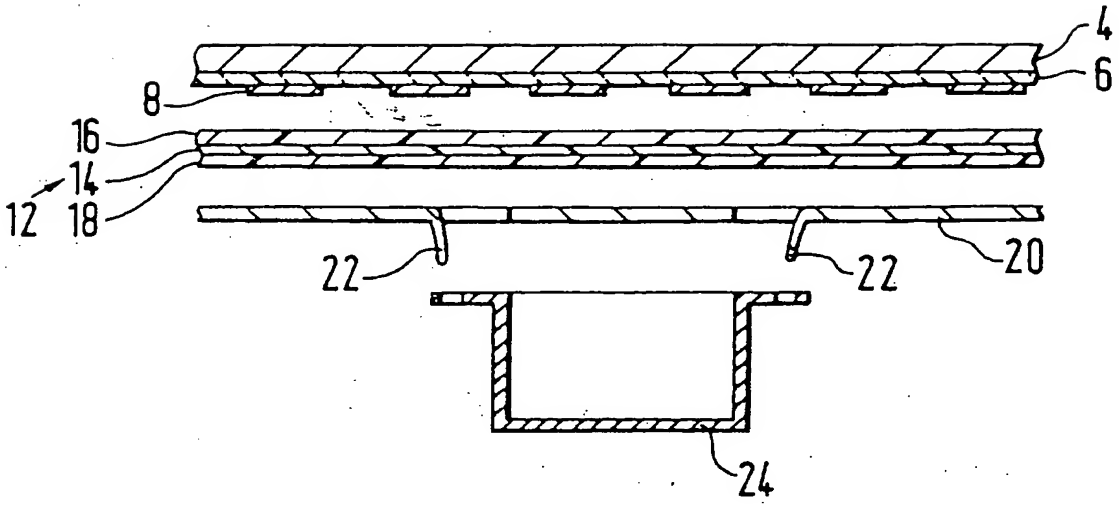

FIG.2

Electric Heaters

The present invention relates to electric heaters and in particular to heaters of the type comprising a resistive heating track laid down on an electrically insulating substrate. In particular, the invention relates to so-called thick-film heaters, in which a thick film heating track is applied, most commonly screen printed, onto a glass, ceramic or glass ceramic (hereinafter collectively referred to as glass) layer typically provided on a metallic support surface.

It has been proposed to use such heaters in liquid heating vessels. In such applications, the heater is provided on the underside of the base of a metal vessel, or, as disclosed in WO 96/18331, on a metal plate which can be mounted in the base of, for example, a plastics vessel.

In such applications, the heater should be provided with a thermally-sensitive control which operates to interrupt or reduce the electrical supply to the heater in the event that the heater overheats, as would happen, for example, if the vessel was switched on without any liquid in it, or if it boiled dry. Typical controls comprise a thermally sensitive actuator such as bimetallic actuator arranged in good thermal contact with the heater. Such controls are shown in WO 95/34187 and in our co-pending application GB 9525493.4.

It has been proposed in WO96/17497 to position the control under a part of the heater track which, under normal operating conditions, will overheat before the rest of the heater in a boil dry or switch on dry situation. However, the heating effect produced by a thick film heater is concentrated in the region of the tracks, and there is relatively little lateral conduction of heat from the tracks, particularly where the support plate is of stainless steel or another metal

which has a relatively low thermal conductivity. Accordingly, if, for example, the vessel is placed on a sloping surface, or if it is replaced incorrectly on a cordless base, the part of the heater in the region of the control may remain cool, whilst an other part of the track may overheat. As there is little lateral conduction of heat in the heater, that part of the track may overheat dangerously before the control operates.

The present invention seeks to overcome the above problem, and from a first aspect, provides a heater comprising a support surface, an electrically insulating layer on said surface, and a resistive heating track, preferably a thick film heating track, applied to the insulating layer, characterised in that a thermal conduction means is arranged in thermal contact with the heater track to improve lateral conduction of heat produced by the track.

In this way, heat generated locally by a portion of the heater which may become uncovered by liquid in a vessel may be conducted laterally to a control, to allow the control to operate before the local region overheats significantly.

Further, this will also allow the heat generated by the heater track to be diffused over a larger area of the heater, allowing the overall temperature of the heater to be reduced during normal operation, thereby prolonging the life of the heater. It will also reduce the temperature of the support plate, thereby reducing the tendency for formation of scale in water heating vessels.

To maximise the thermal conduction and reduce the risk of local overheating, the heat conduction means preferably extends over a substantial area of the heater track.

The thermal conduction means is preferably metallic, and more particularly of a metal having a high thermal conductivity such as aluminium, copper or alloys

thereof.

Preferably the thermal conduction means is arranged over and in good thermal contact with the tracks on the side away from the support plate. However, it would also be possible to arrange it on or in the support plate, for example as a layer of copper or the like sandwiched between two layers of stainless steel.

Preferably, the thermal conduction means is in the form of a member such as a strip or more preferably a plate. The thermal mass of the member should not be excessive in order to allow heat to be conducted rapidly to a control in an overheat condition. Preferably, therefore it is relatively thin, for example less than 3mm thick, although in certain applications it may be considerably thinner. For example, it may be possible to use an extremely thin foil of copper, say 0.1mm thick, to obtain the necessary thermal conduction

. Mounting means may be provided on the support plate for mounting a thermally sensitive control, but preferably the thermal conduction member has such means. Preferably the thermal conduction member is punched or stamped to form one or more mounting lugs over which the control may locate. To provide the requisite strength the thermally conductive member is preferably about 1 to 2mm thick.

Preferably the thermally conductive member is bonded, for example adhesively secured to the heater. Alternatively, a glass layer could be provided as an overglaze on the tracks and that layer act to bond the member in position.

The track may be provided, if required, with a glass overglaze or other protective layer to protect it from corrosion and to insulate the thermal conduction member from the track, and the thermal conduction member be arranged against that layer. This is not essential, however, and indeed it is preferred to dispense with the

overglaze, to improve thermal conduction from the track into the thermal conduction member. However, the thermal conduction member will still need to be electrically insulated from the track, so an electrically insulating film may be provided between the track and the thermal conduction member. Preferably this film is of or contains a plastics material, for example a Nomex paper or Kapton plastics film. A film having a thickness of as little as 25 microns can provide adequate electrical insulation, while at the same time presenting a relatively low thermal resistance, allowing heat to flow quite readily into the thermal conduction member from the track.

The insulating film may be provided as a coating on the heater but preferably it is a separate component. Advantageously, the film may be provided with an adhesive on one or both sides to allow the thermal conduction member to be adhered to the heater as is preferred. This provides a particularly simple way in which the member may be mounted to the heater. For example a 50 micron layer of a thermoset or contact adhesive could be provided on both sides of a Kapton film. Alternatively, the thermal conduction member could be provided with an adhesive on one side to adhere it to the heater. Clearly the adhesive used should be able to withstand the anticipated operating temperature of the heater.

The invention also extends to the assembly of a heater in accordance with the invention and a thermally sensitive control, and to a liquid heating vessel comprising a heater or assembly in accordance with the invention. Preferably he heater of the invention is mounted on the base of the vessel.

A preferred embodiment of the invention will now be described by way of example only with reference to the accompanying drawing in which:

Figure 1 shows a plan view of a heater in

accordance with invention; and

Figure 2 shows an exploded sectional view through the heater of Figure 1.

With reference to the Figures, a thick film printed heater 2 comprises a stainless steel plate 4 upon which is provided an electrically insulating glass layer 6 upon which in turn is applied a tortuous printed heating track 8. The track 8 has contact portions 10 for making electrical connection to an electrical supply for the heater. The layer 6 and track 8 can be applied and fired in any suitable manner.

Over substantially the whole track 8 is arranged a laminated plastics film 12 comprising a 25 micron thick Kapton film 14 which is provided on both sides with respective thermosetting or contact adhesive layers 16,18 each approximately 50 micron thick.

On top of the laminated film 12 is arranged a thermally conductive aluminium plate 20. The plate 20 is approximately 2mm thick and extends over substantially the whole of the heater track 8. The plate 20 is mounted to the heater 2 via the adhesive coated film 12.

As can be seen in Figure 2, the plate 20 is punched through to form two upstanding lugs 22 for mounting a thermally sensitive control 24, which is positioned over the lugs 22, which can be crimped over to secure the control 24 in position. The control has an actuator (not shown) which is in good thermal contact with the plate 20.

The control 24 is positioned at a part of the heater 26 which is intended to overheat preferentially under normal operating conditions, for example, at a position where it will be exposed before other areas of the heater. For example the heater may be mounted at an angle in the band of a liquid heating vessel and the control arranged under the highest part of the heater which will become exposed as liquid evaporates.

In operation, the plate 20 acts to conduct heat away from the track 8 laterally which lowers the overall temperature of the track, thus prolonging the heater life. Moreover, if a hot spot develops in the heater, as might happen if a vessel boils dry, heat will be conducted away from that hot spot to the control 24 which may then operate before dangerous overheating occurs in any particular section of the heater.

Claims

1. A heater comprising a support surface, an electrically insulating layer on said surface, and a resistive heating track, applied to the insulating layer, characterised in that a thermal conduction means is arranged in thermal contact with the heater track to improve lateral conduction of heat produced by the track.

2. A heater as claimed in claim 1 wherein the heat conduction means extends over a substantial area of the heater track.

3. A heater as claimed in claim 1 or 2 wherein the thermal conduction means is of a metal having a high thermal conductivity.

4. A heater as claimed in claim 3 wherein the thermal conduction means is of aluminium, copper or alloys thereof.

5. A heater as claimed in any preceding claim wherein the thermal conduction means is a relatively thin member such as a plate or strip arranged over the track.

6. A heater as claimed in claim 5 wherein the thermal conduction member is less than 3mm thick.

7. A heater as claimed in claim 5 or 6 wherein the thermal conduction member is formed with means to mount a thermally sensitive control.

8. A heater as claimed in any preceding claim wherein the thermal conduction means is bonded to the heater.

9. A heater as claimed in any preceding claim wherein an insulating film is provided between the thermal conduction member and the heater track.

10. A heater as claimed in claim 9, wherein said film is plastics.

11. A heater as claimed in claims 9 or 10 and 11 wherein said film is coated with an adhesive for securing the thermal conduction member in position.

12. In combination, a heater as claimed in any preceding claim and a thermally sensitive control therefor arranged in good thermal contact with the heat conduction means of the heater.

13. A liquid heating vessel comprising a heater or combination as heater as claimed in any preceding claim.

14. A liquid heating vessel as claimed in claim 13 wherein said heater is provided in the base of the vessel.

The Patent Office

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Claims searched:	1-14	**Date of search:**	25 September 1996

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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Int Cl (Ed.6): H02B [03/82, 03/26, 03/30, 03/32]; A47J [27/21]

Other: Optics: H5H

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2187836A	THORN - see whole document	1-5,8 at least
X	EP0636332A1	SEB - see plate 10	1,13 at least
X	WO93/02533A1	GLOBAL - see insulated element	1,9 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.